8.2 CELL RESPIRATION

OXIDATION AND REDUCTION-

Oxidation is the process where:

- oxygen is added
- hydrogen is removed
- loss of electrons

O_2 +
H -
e-

Reduction happens when:

- oxygen is removed
- Hydrogen is added
- addition of electrons

O_2 -
e +
H +

Redox is the process where both, oxidation and reduction occur.

Electron carriers: Substances that can accept and give up electrons as required. They link oxidation & reduction reactions in the cell.

main electron carrier in cell respiration is NAD (Nicotinamide adenine dinucleotide)

$NAD + 2e^- \rightarrow$ reduced NAD - basic reaction.

$NAD^+ + 2H^+ + 2e^- \rightarrow NADH + H^+$

Respiration pathway can be divided into 4 parts:

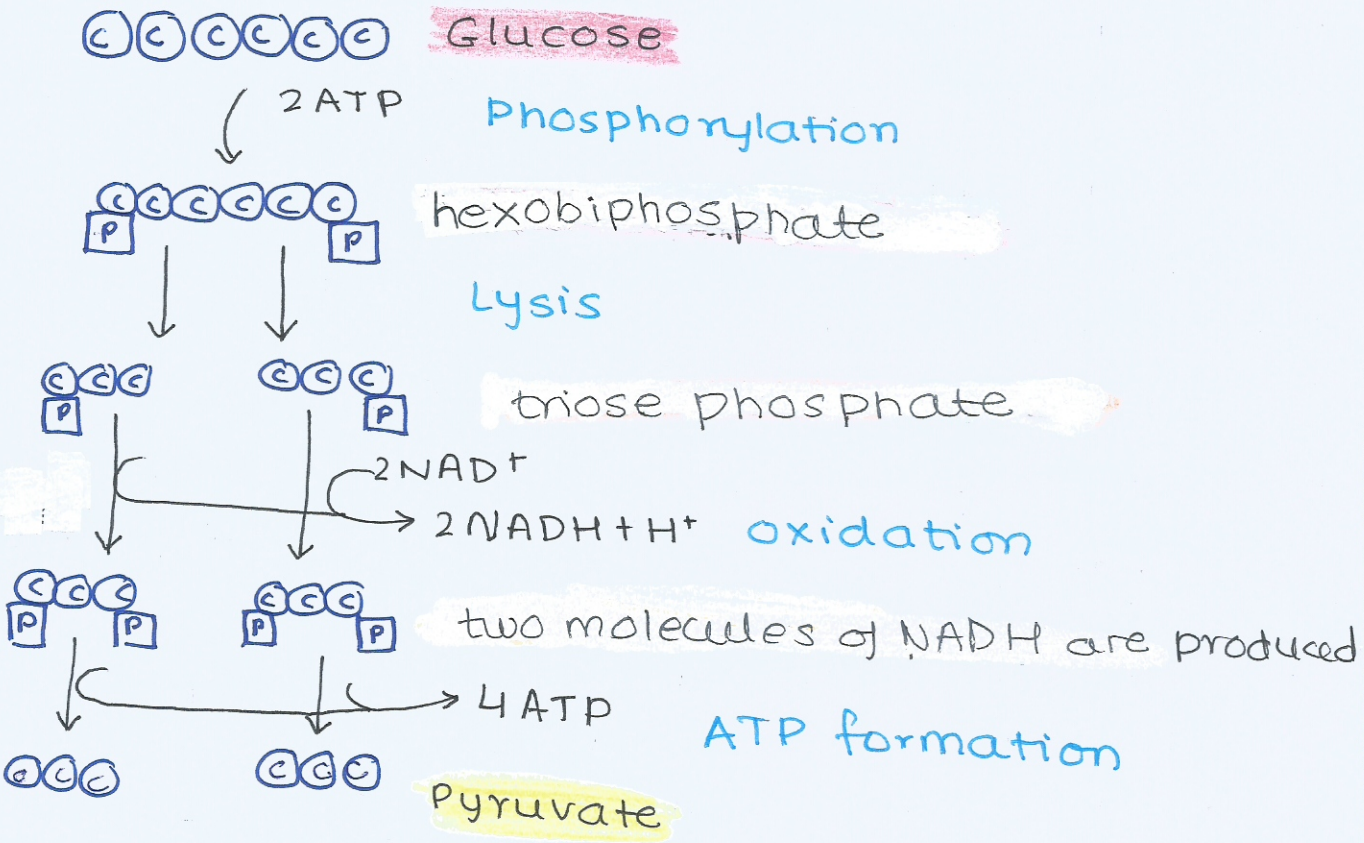
- Glycolysis
- Link Reaction
- Krebs cycle
- Electron Transport chain & chemiosmosis.

GLYCOLYSIS

→ occurs in the cytoplasm of the cell

→ anaerobic process

→ produces pyruvate and a small amount of ATP.



Net Gain: 2x ATP, 2x NADH + H+, (+2 x pyruvate)

Phosphorelation

- Glucose gets phosphorelated (2 phosphate groups are added to it) and produces a hexose biphosphate.
- This process helps reduce the activation energy for the upcoming processes.

Lysis

- The 6 C sugar is split into 3C sugars.

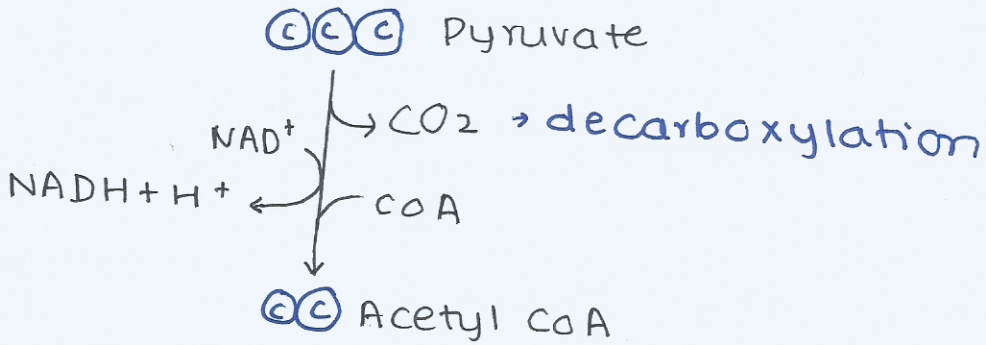
Oxidation

- H atoms are removed from 3c sugars to reduce NAD^+ to $NADH + H^+$.

ATP formation

The phosphate groups on the 3 carbon sugars are transferred onto ADP molecules to form 2 molecules of ATP.

LINK REACTION



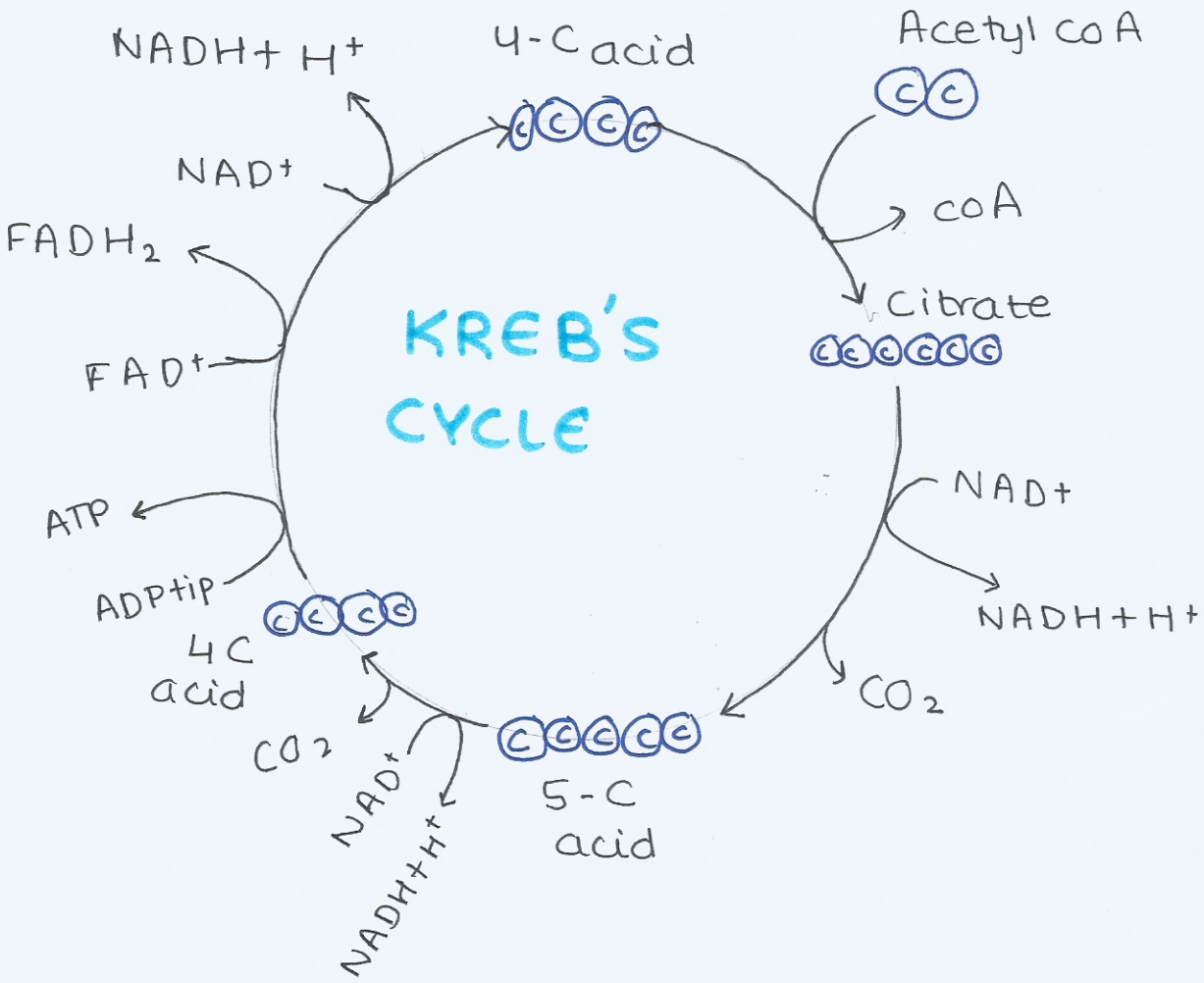
- Pyruvate is transported to the matrix of the mitochondria.
- Pyruvate loses a carbon atom by decarboxylation.
- 2 C compound forms an acetyl group as it loses H atoms. As a result NAD+ is reduced to NADH + H+.
- Acetyl group combines with co enzyme A to form Acetyl Co A.

Net Result: (For two pyruvates)

$2 \times CO_2$, 2 x NADH + H+

KREB'S CYCLE

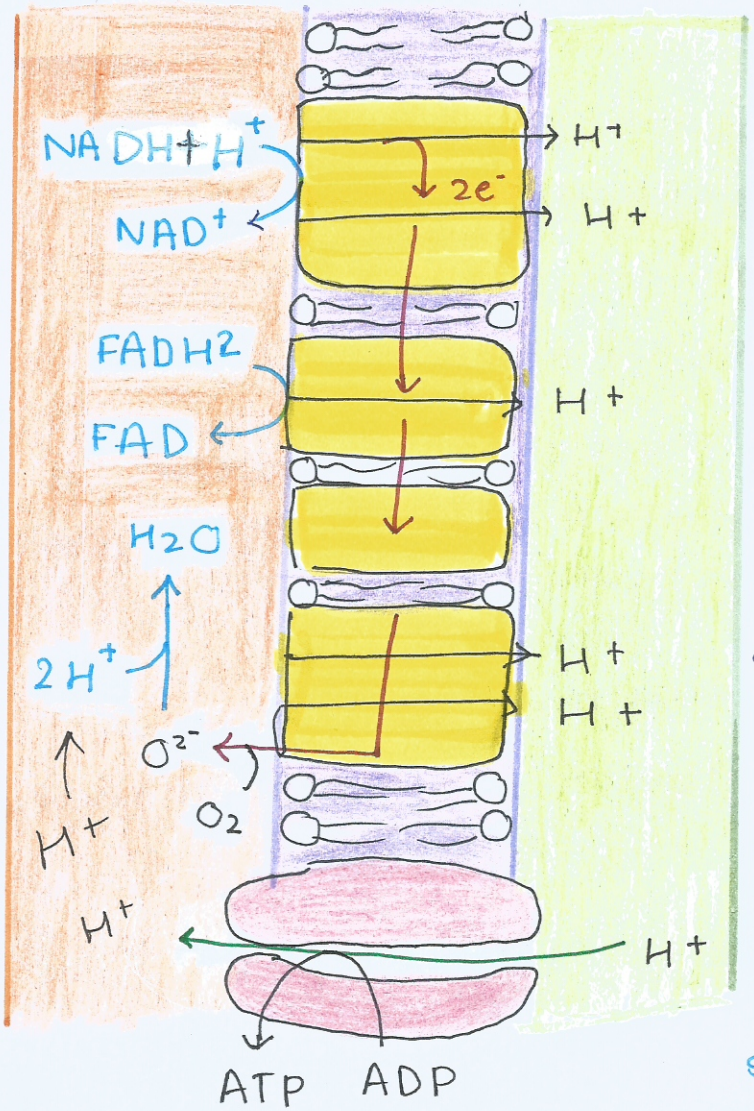
- occurs in the matrix of the mitochondria
- also called as citric cycle



- Acetyl CoA is taking part in the Kreb's cycle and the co enzyme A is removed to be recycled.
- Acetyl group is added to oxaloacetate (4-C) to make citrate.
- The citrate (6-C) compound is broken down to form the original 4-C compound. In the process,
- 2 C atoms are released via decarboxylation as CO_2.
- Oxidation reactions occur to reduce the hydrogen carriers. (3 NADH+H$^+$, $FADH_2$)
- One molecule of ATP is produced.

Net Result: 6 NADH+H$^+$, 2$FADH_2$, 2ATP, 4CO_2

ELECTRON TRANSPORT CHAIN



inter membrane

inner mitochondrial membrane

matrix

- Most of the ATP produced from the breakdown of glucose occurs in the ETC.
- The inner membrane has molecules called the electron carriers.

They pick up electrons and pass them from one to another in a series of oxidations & reductions.

- Reduced NAD and $FADH_2$ donate their electrons to these electron carriers.
- Energy is released as these electrons pass from carrier to carrier and this energy is used to transport protons (H^+) from the matrix to the inter membrane.
- A concentration gradient is formed and this proton gradient is a store of potential energy.

OXIDATIVE PHOSPHORYLATION

- At the end of the chain, the electrons are combined with oxygen to make O_2^- and this combines with protons to make water. This is the oxidative part of oxidative phosphorelation.

CHEMIOSMOSIS

- As a concentration gradient is formed, the protons move from the high concentration area (inter membrane space) to the low concentration area (matrix) through an integral protein.
- It is the process where there is a passive flow of protons down a concentration gradient through a partially permeable membrane.

The protein contains the enzyme ATP synthase which joins ADP and inorganic phosphate to make ATP.

OXIDATIVE PHOSPHORYLATION

The electrons from one $NADH + H^+$ pumps 4 protons into the inter membrane space, each $NADH + H^+$ results in the formation of 3 ATP.

$FADH_2$ also supplies electrons to the electron transport chain but further down the chain. ∴ producing only 2 ATP.

This is the phosphorylation part of it.

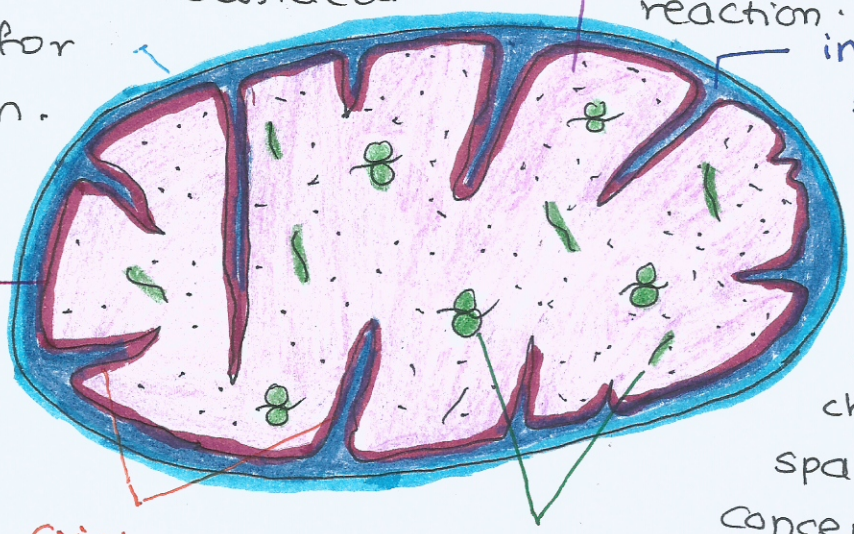
STRUCTURE AND FUNCTION OF MITOCHONDRIAN

Outer membrane

It separates the contents of the mitochondrian from rest of the cell, creating a cellular compartment. Allowsideal condition for respiration.

Matrix

contains enzymes for Kreb's cycle & link reaction.



inter membrane space

Proteins are pumped into this space by electron transport chain. small space allows the concentration to build up quickly.

Inner membrane

contains ETC & ATP synthase

Cristae

projections which increase the surface area available for oxidative phosphorylation.

Ribosome and DNA

for expression of mitochondria -l genes.

Glycolysis takes place in the cytoplasm of the mitochon-drion.

Link Reaction occurs in the mitochondrial matrix.

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